# Physics PHYD38
# Nonlinear systems and Chaos

## Winter 2021

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**Office Hours:** Virtual, by appointment

## TIME & PLACE:

Mondays 10am-12noon (Synchronous Lectures)
Mondays 2-3pm (Synchronous Tutorials)

## DESCRIPTION:

Many physical systems of great interest are subject to non-linear dynamics and extreme sensitivity to initial conditions (e.g. the weather). As a result, despite obeying deterministic laws, accurate predictions of the system's long-term future become impractical. This class will provide students with the basic knowledge needed to understand the principles behind deterministic chaos in nonlinear systems and will expose them to various applications in physics, astrophysics and beyond (e.g. biology).

## TOPICS:

- Introduction to Nonlinear Dynamics
- Phase Space, Flows in Phase Space
- Bifurcations, Limit Cycles
- Numerical solutions to Differential Equations
- Deterministic Chaos
- Fractals and Strange Attractors
- Applications to Physics and Beyond

## PREREQUISITES:

A working knowledge of calculus and calculus-based general physics.

Prerequisite: PHYC54H3
Corequisite: --
Exclusion: PHY460H

Breadth Requirement: Natural Sciences

## TEXTBOOK:

**Nonlinear Dynamics and Chaos (by Steven H. Strogatz)**

## PROBLEM SETS:

Handed out in class and posted on this website, approximately every other week (total of 4-5). Due one week later.

**Policy on collaboration:** You are welcome to discuss the problems with fellow students, but you must write your own solutions, individually.

**Policy on late problem set returns:** In order to be fair to those who turn assignments in on time, points will be deducted on assignments turned in late.

## GRADING:

Problem sets: 50%
Midterm exam: 20%
Final exam: 30%

## APPROXIMATE SCHEDULE:

1. Introduction, organisation and overview
2. Flows on the Line
3. Bifurcations of 1D systems
4. Flows on the Circle
5. 2D Linear Systems
6. Phase Plane
7. Limit Cycles
8. 2D Bifurcations
9. 3D systems: Lorenz model
10. One-dimensional maps
11. Fractals
12. Strange Attractors